CEOS Systems Engineering Office (SEO)

CEOS SEO and GISS Meeting

Brian Killough
Shelley Stover
March 21, 2008

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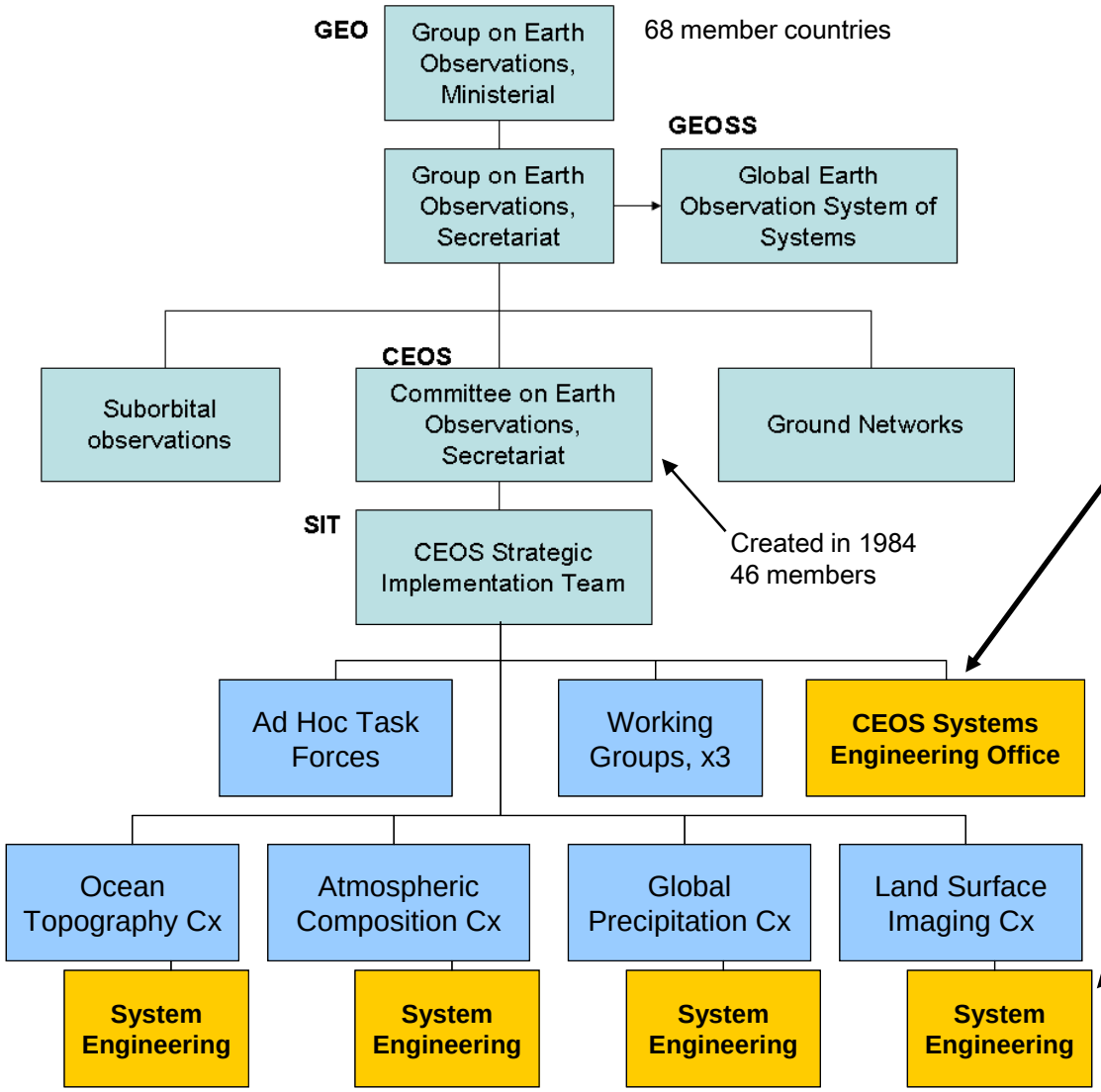
CEOS SEO Background



CEOS Systems Engineering Office (SEO)

NASA LaRC was asked to lead the systems engineering effort in early 2007. The SEO was established in **April 2007** to support the CEOS SIT, CEOS Constellation Teams and CEOS Working Groups.

SEO Charter

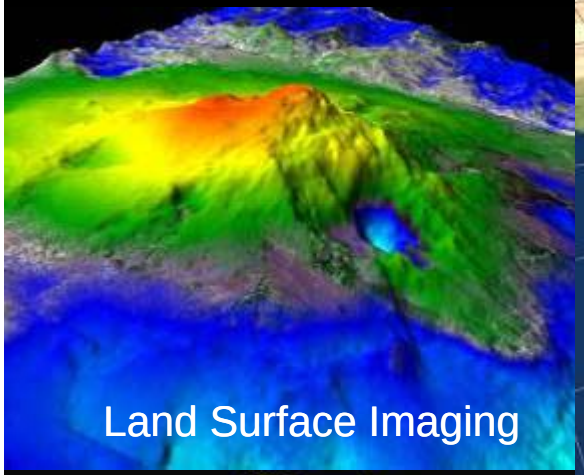
- systems engineering framework
- requirements definition
- mission assessment and studies
- constellation architecture planning
- foster communication within CEOS

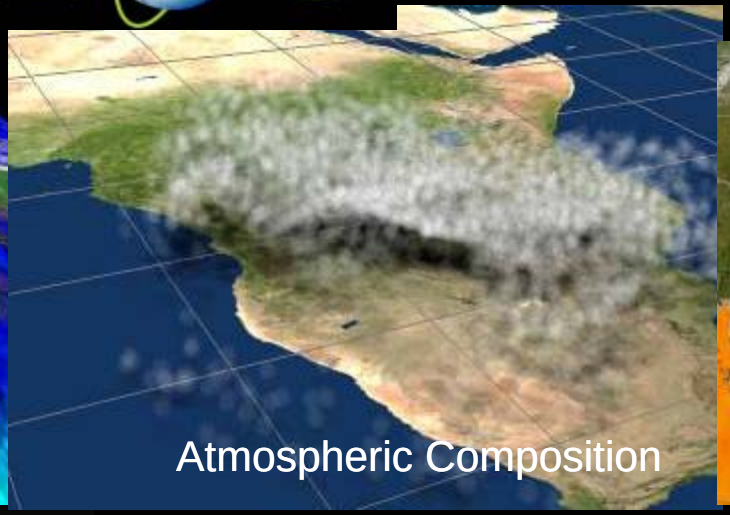
CEOS Constellations

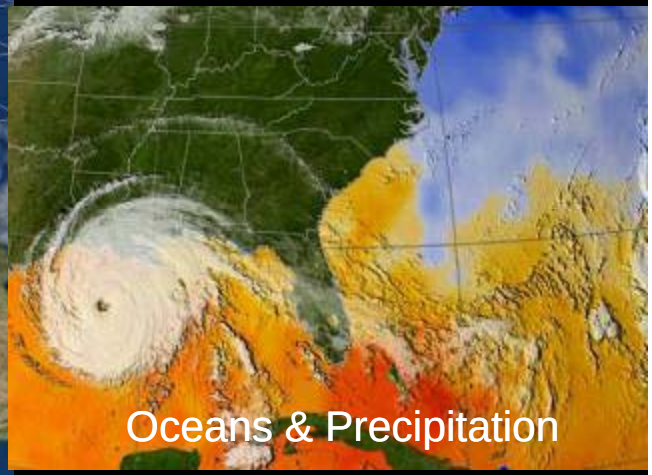
Support four constellation created in 2006 to bring about technical and scientific cooperation and collaboration among space agencies.

CEOS

Committee on Earth Observation Satellites







Completed a 14-minute narrated video for CEOS in November 2007. The video illustrates how current and future international satellite constellations can collectively observe the land, oceans, precipitation, and atmosphere of the Earth, for the benefit of society. It presents results from remote sensing of volcanic eruptions, tropical deforestation, biomass burning, smoke dispersion, greenhouse gases, floods, hurricanes, and rising sea levels. DVD's were distributed at the CEOS Plenary and GEO (Group on Earth Observation) Plenary meetings.

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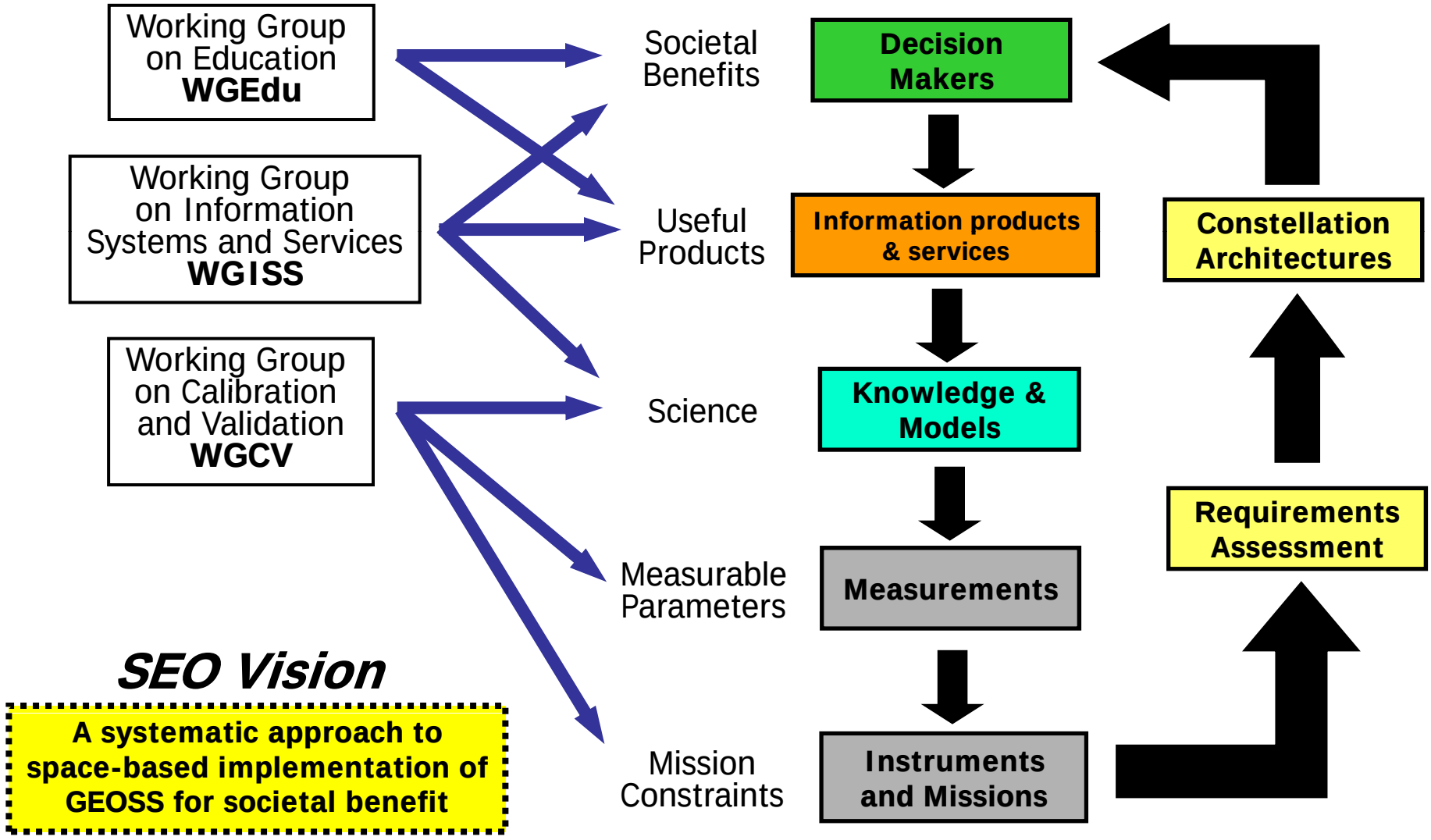
A "System" Framework for GEOSS



SEO Vision

A systematic approach to space-based implementation of GEOSS for societal benefit

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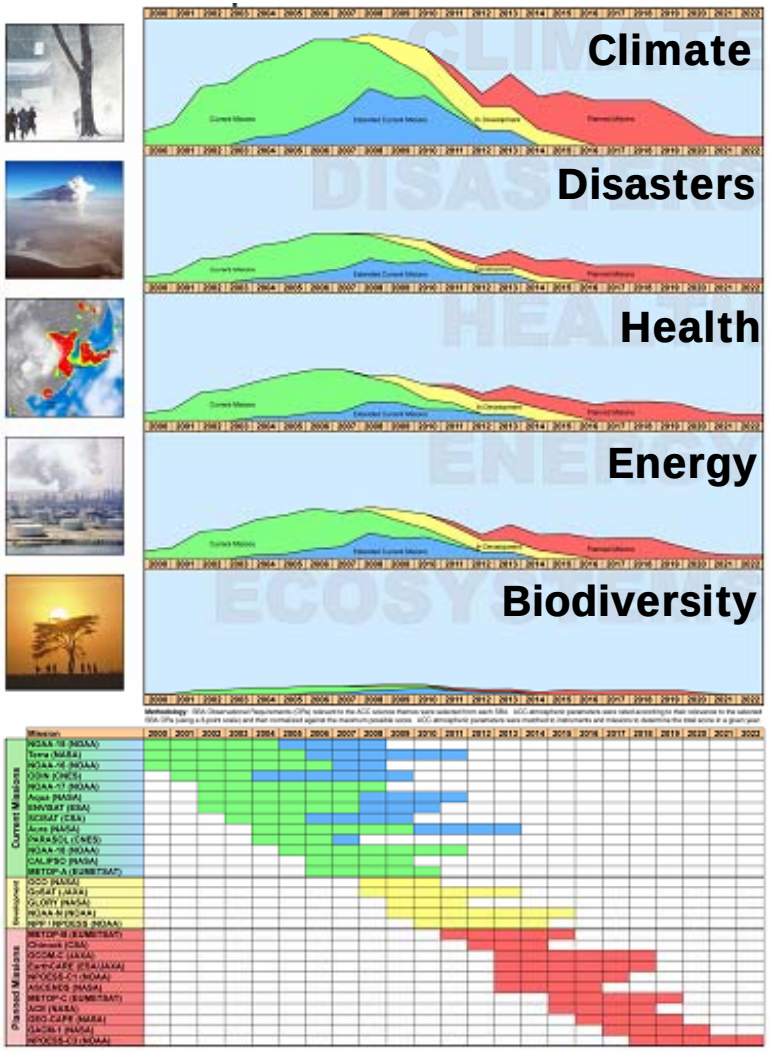
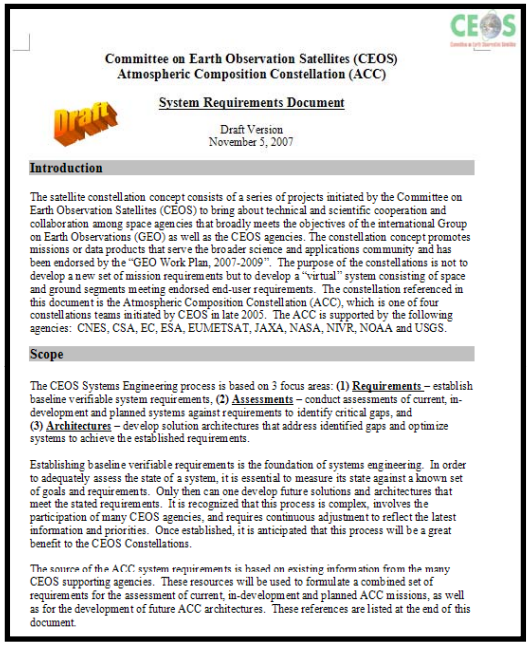
Atmospheric Composition Constellation

SBA Impact Assessment and Mission Architecture Assessment





Committee on Earth Observation Satellites (CEOS)
Atmospheric Composition Constellation (ACC)

System Requirements Document

Draft Version
November 5, 2007

Introduction

The satellite constellation concept consists of a series of projects initiated by the Committee on Earth Observation Satellites (CEOS) to bring about technical and scientific cooperation and collaboration among space agencies that broadly meets the objectives of the international Group on Earth Observations (GEO) as well as the CEOS agencies. The constellation concept promotes missions or data products that serve the broader science and applications community and has been endorsed by the "GEO Work Plan, 2007-2009". The purpose of the constellations is not to develop a new set of mission requirements but to develop a "virtual" system consisting of space and ground segments meeting endorsed end-user requirements. The constellation referenced in this document is the Atmospheric Composition Constellation (ACC), which is one of four constellations teams initiated by CEOS in late 2005. The ACC is supported by the following agencies: CNES, CSA, EC, ESA, EUMETSAT, JAXA, NASA, NIVR, NOAA and USGS.

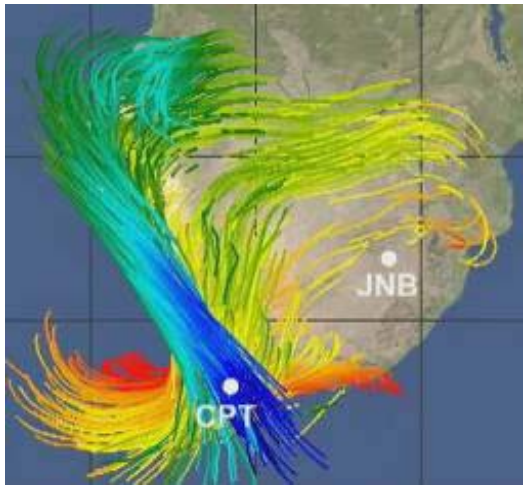
Scope

The CEOS Systems Engineering process is based on 3 focus areas: **(1) Requirements** – establish baseline verifiable system requirements, **(2) Assessments** – conduct assessments of current, in-development and planned systems against requirements to identify critical gaps, and **(3) Architectures** – develop solution architectures that address identified gaps and optimize systems to achieve the established requirements.

Establishing baseline verifiable requirements is the foundation of systems engineering. In order to adequately assess the state of a system, it is essential to measure its state against a known set of goals and requirements. Only then can one develop future solutions and architectures that meet the stated requirements. It is recognized that this process is complex, involves the participation of many CEOS agencies, and requires continuous adjustment to reflect the latest information and priorities. Once established, it is anticipated that this process will be a great benefit to the CEOS Constellations.

The source of the ACC system requirements is based on existing information from the many CEOS supporting agencies. These resources will be used to formulate a combined set of requirements for the assessment of current, in-development and planned ACC missions, as well as for the development of future ACC architectures. These references are listed at the end of this document.

System Requirements Document using the SEO framework



Fire/Smoke Aerosol Project led by Jack Fishman (NASA LaRC) utilizing CALIPSO data

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SEO Climate Related Tasks for 2008

- Assess the ECV parameters and identify missing parameters or inconsistencies between GEOSS, GCOS and CEOS documentation.
  - Example: ECV's relate to 33 of the 36 (92%) GEOSS 10-yr Plan Climate SBA Observational Requirements.
  - Example: Missing "Terrestrial Reanalysis"
- Using the "systems framework" determine relevant informational products and science models.
- Perform assessments and gap analyses of measurements and missions for each ECV.
- Engage CEOS Working Groups, GEO Climate SBA lead, GCOS in developing requirements and reviewing assessments.

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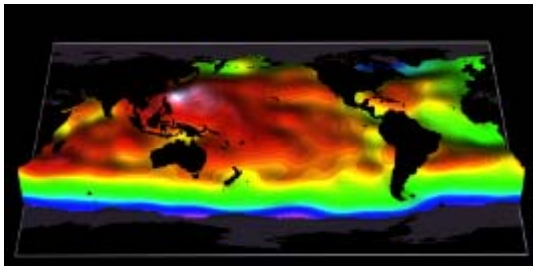
Essential Climate Variables (ECV)

- **28 total ECVs** - space-based measurable atmospheric, ocean and terrestrial parameters including TWO “Reanalysis” ECV’s (A8 and O6) for Oceans and Atmosphere.



A.	**Atmosphere**
A.1	Surface Wind Speed and Direction
A.2	Upper-air Temperature
A.3	Water Vapor
A.4	Cloud properties
A.5	Precipitation
A.6	Earth Radiation Budget
A.7	Ozone
A.8	Atmospheric Reanalysis (multiple ECVs)
A.9	Aerosols
A.10	CO_2, CH_4 and other Greenhouse Gases
A.11	Upper-air Wind

O.	**Oceans**
O.1	Sea Ice
O.2	Sea Level
O.3	Sea Surface Temperature
O.4	Ocean Color
O.5	Sea State
O.6	Ocean Reanalysis (Multiple ECVs)
O.7	Ocean Salinity

T.	**Terrestrial**
T.1	Lakes
T.2	Glaciers and Ice Caps, and Ice Sheets
T.3	Snow Cover
T.4	Albedo
T.5	Land Cover
T.6	fAPAR (Fraction of Absorbed Photosynthetically Active Radiation)
T.7	LAI (Leaf Area Index)
T.8	Biomass
T.9	Fire Disturbance
T.10	Soil moisture

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Example Requirements: Climate (Ocean Domain)

Decision Makers

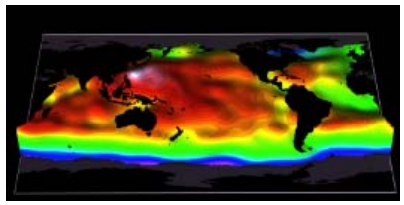
- Policies for coastal population growth
- Disaster plans for hurricane flooding
- Water usage restrictions
- Initiatives impacting global warming

Information products & services

- Forecasts (mean sea level, storm surge level)
- Warnings (hurricane, flood, drought)
- Maps (hurricane storm surge, stream flow, water storage)

Knowledge & Models

- Sea Level Rise Models
- Climate Models (Global Warming, El Nino and La Nina)
- Hurricane, Flood, Drought Models
- Stream Flow and Water Storage Models



Measurements

- **Sea Level** (Sea Surface Height – SSH)
- **Sea Surface Temperature** (SST)
- **Sea State** (surface winds, wave information)

ECVs – Essential Climate Variables

Instruments and Missions

Instruments

- Radar Altimeter (Sea Level)
- Synthetic Aperture Radar (Sea State)
- Wind Scatterometer (Sea State)
- Imager (Sea Surface Temperature)

Missions

- TOPEX/Poseidon, Jason 1,2,3 (high precision)
- ERS-2, ENVISAT (in orbit, complementary)
- Cryosat-2, HY-2A, SARAL, Sentinel-3A, SWOT (future)

Significance of Top Down Requirements

- Established traceability from instruments to products and services would allow for benefit evaluation of instruments and measurements
  - Would provide CEOS organizations a tool that could define gaps and overlaps in instruments and measurements
  - With weightings at each level, this tool would provide decision makers with a way to evaluate the societal benefit of their investments
- Traceable Climate requirements would provide a better understanding of global climate models
  - Would allow a broader community the insight to global climate models, their inputs and data outputs
  - With this knowledge, contributions to these models could come from unlikely sources

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GISS Inputs to the CEOS SEO Climate Analysis

Decision Makers

Information products & services

Knowledge & Models

Measurements

Instruments and Missions

Users Table Required Fields
- User name
- Information Products required
- Other information required

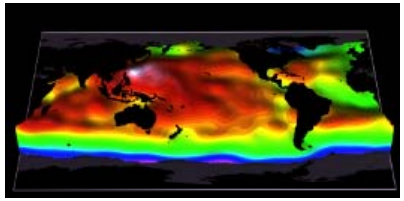
Products Table Required Fields
- Product name
- Model Outptus required
- Other information required

Who uses your model output data to develop products?

Models Table Required Fields
- ***Model name***
- ***Input measurements required***
- ***Measurement accuracy required***
- ***Measurement coverage required***
- ***Model Outputs***

Can we get all the specifics of your GCM model ? What are the inputs? Where do they come from? What inputs are lacking or could be improved?

Measurements Table Required Fields
- Measurement
- Horizontal resolution
- Vertical Resolution
- Accuracy



Missions & Instrument s Table Required Fields
- Mission
- Instrument
- Measurements
- Horizontal resolution
- Vertical Resolution
- Accuracy
- Frequency

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Contact Information

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